An Automated Method For Ozonesonde Preparation And Calibration

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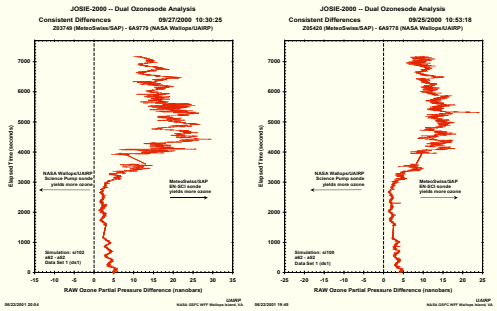
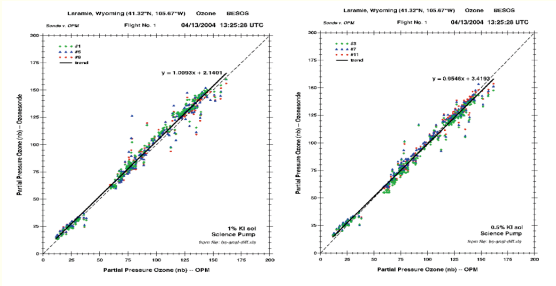
Remote measurements of ozone from instruments on AURA, AQUA, SAGE, and other satellite-borne instruments provide quite good measurements. Nevertheless, they depend on other measurements to insure that changes to their data quality does not occur. One important, but basic independent measurement method is the balloon-borne ozonesonde discussed here and its measurement reliability. Ozonesondes released from Wallops Island since 1970 used various concentrations of potassium iodide (KI) solution raising the question: which concentration should be considered correct? Three KI concentrations have been used and Wallops is currently considering another change to the concentration. Beginning in 1970, ozonesondes used two-percent KI concentration but was changed to one and one-half percent concentration in 1972 which continued for 20 years. In 1995, the KI concentration was reduced once more to one percent. However, instrument comparisons such as JOSIE2000, BESOS, and unique in-house dual instrument comparisons indicate quite strongly that the Science Pump Co. (SPC) ozone sensors might operate and give better results if a one-half percent KI solution is used.

The Jülich Ozone Sonde Intercomparison Experiment 2000 (JOSIE2000) conducted in the high altitude simulation chamber at Forshungszentrum Jülich, Germany, showed that ozone measurements from different instruments are not the same under the same test conditions and also compared differently with a reference UV photometer (Proffitt etal 1983). The figure below shows differences between ECC's of SPC (provided by NASA) and ENSCI (provided by MeteoSwiss). Both ECC types were prepared with one-percent KI solution. Tropospheric differences are relatively small compared with the larger differences in stratosphere, up to 8 percent.

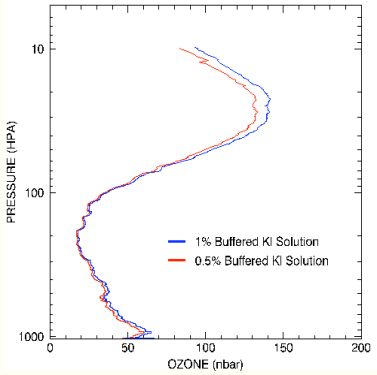


A second comparison, BESOS or Balloon Experiment on Standard Operating procedures for ozone Sondes, took place at the Univ. Wyoming in April 2004. Twelve instruments, six SPC and six ENSCI, were compared against each other and with the same photometer used in the JOSIE2000 test. New information on their comparability and the KI solution that works best with either is available. Half of the SPC and ENSCI instruments were each prepared with one-percent KI and half with one-half percent. The agreement of the SPC ECC with the photometer is obvious in the figure below. The left panel is a result when 1 percent KI is used; the right panel the result of 0.5 percent KI. There clearly is better agreement using the 0.5 percent KI. Result from the dual instrument flight tests at Wallops, the Jülich simulations, and BESOS are consistent. Tests recently completed at Wallops Island using the computer-controlled digital calibration facility also support these results.



Because of questions surrounding ECC preparation and proper KI concentration issues other comparison and dual instrument tests were undertaken earlier at Wallops Island. The figure below represents averages of two-dozen dual flights. Little difference is noted at atmospheric pressures higher than 100 hPa between 1.0 percent and 0.5 percent KI concentrations. The individual profiles repeated each other well. In the stratosphere there is a much larger difference, reaching nearly 7 percent, consistent with the Jülich result.

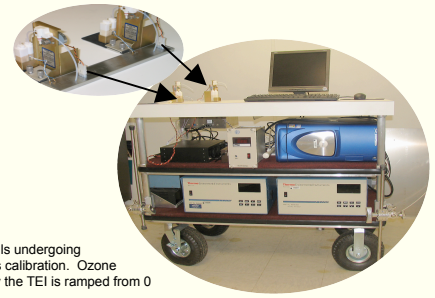
From the foregoing discussion we find that there is a measurement difference between Science Pump Corp. and En-Sci Corp ECC instruments as well as measurement differences when different KI solution concentrations are employed. These tests indicate that the Science Pump instrument might provide more representative values of ozone partial pressure using 0.5 percent KI solution.



References:
Deshler, T., etal 2006: Balloon experiment to test ECC-ozonesondes from different manufacturers, and with different cathode solution strengths: Results of the BESOS flight. In Preparation.
Proffitt, M. H., and R. J. McLaughlin, 1983: Fast response dual-beam UV-absorption photometer suitable for use on Stratospheric Balloons, Rev. Sci. Instrum., 54, 1719-1728.
Smit, H. G. J., etal 2006: Assessment of the performance of ECC-ozonesondes under quasi-flight conditions in the environmental simulation chamber: Insights from the Jülich Ozone Sonde Intercomparison Experiment (JOSIE), J. Geophys. Res., submitted March 2006.

Differences between Science Pump and En-Sci ECC's were investigated during the JOSIE2000 (Smit et al, submitted to JGR) and BESOS (Deshler etal,in preparation) comparisons. Eventually, the question of the proper KI concentration will be resolved. With this issue in mind, an automatic digital calibration facility was put into use at Wallops Flight Facility capable of comparing different KI solution concentrations.

NASA's digital calibration system is computer controlled and improves ECC calibration while removing subjectivity that may be associated with manual preparation and calibration. Comprehensive evaluation of sensor performance over a range of ozone values and simultaneous comparison of KI concentrations is possible. All measurement parameters and data are preserved digitally for analysis, including resolving post-flight data questions. We expect variability currently affecting long-term measurements to be reduced. The picture below reveals the test apparatus and includes a TEI analyzer and a TEI monitor, mass flow meter, functional electronics, and computer. In the insert two ECC sensors undergoing evaluation with two KI concentrations: 1.0 and 0.5 percent.



Two ECC cells undergoing simultaneous calibration. Ozone generated by the TEI is ramped from 0 to 200 ppmv.

The only manual preparation step required is the introduction of KI solution into the cells. At Wallops Island, cells are prepared at least three weeks and recharged once per week until instrument release. The graphs below show four successive calibrations, one week apart. Week 1 is initial preparation showing the poor result if the instruments would be used immediately. Measurements are referenced to the TEI analyzer and following week 2 both sensors are noted to be stable. The red curve represents 1.0 percent and the blue curve the 0.5 percent KI concentrations. The 0.5 percent concentration agrees better with the reference.